

# INTERNATIONAL COOPERATION TREATY

## PCT

### NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
US Department of Commerce  
United States Patent and Trademark  
Office, PCT  
2011 South Clark Place Room 524  
Arlington, VA 22202  
ETATS-UNIS D'AMERIQUE  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year)  
26 October 2000 (26.10.00)

International application No.  
PCT/AU00/00226

Applicant's or agent's file reference  
#30732dab:ct

International filing date (day/month/year)  
22 March 2000 (22.03.00)

Priority date (day/month/year)  
23 March 1999 (23.03.99)

Applicant

DOBSON, Geoffrey, Phillip

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

11 October 2000 (11.10.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

F. Baechler

Telephone No.: (41-22) 338.83.38

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 20 MAR 2001

WIPO

PCT

14

Applicant's or agent's file reference BJN:MAR:FP12835	<b>FOR FURTHER ACTION.</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. PCT/AU00/00226	International Filing Date (day/month/year) 22 March 2000	Priority Date (day/month/year) 23 March 1999
International Patent Classification (IPC) or national classification and IPC  Int. Cl. <sup>7</sup> A01N 1/02		
Applicant JAMES COOK UNIVERSITY et al		

1.	This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2.	This REPORT consists of a total of 4 sheets, including this cover sheet.  <input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  These annexes consist of a total of 6 sheet(s).
3.	This report contains indications relating to the following items:  I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input type="checkbox"/> Certain defects in the international application VIII <input type="checkbox"/> Certain observations on the international application

Date of submission of the demand 11 October 2000	Date of completion of the report 5 March 2001
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer  JAMIE TURNER Telephone No. (02) 6283 2071

**I. Basis of the report**

1. With regard to the **elements** of the international application:\*
- ☐ the international application as originally filed.
- ☒ the description, pages **1-48**, as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☒ the claims, pages **49-54**, as originally filed,  
pages , as amended (together with any statement) under Article 19,  
pages , filed with the demand,  
pages , received on with the letter of
- ☒ the drawings, pages **1/15-6/15, 13/15-15/15**, as originally filed,  
pages , filed with the demand,  
pages **7/15-12/15**, received on **27 February 2001** with the letter of **26 February 2001**
- ☐ the sequence listing part of the description:  
pages , as originally filed  
pages , filed with the demand  
pages , received on with the letter of
2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.  
These elements were available or furnished to this Authority in the following language which is:
- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, was on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished
4. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.
5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Claims 6-27, 30-43	YES
	Claims 1-5, 28-29	NO
Inventive step (IS)	Claims 8, 14-24, 30-43	YES
	Claims 1-7, 9-13, 25-29	NO
Industrial applicability (IA)	Claims 1-43	YES
	Claims	NO

**2. Citations and explanations (Rule 70.7)**

The abbreviations D1-D6 listed hereinafter are the documents in the order cited in the corresponding international search report:

D1 - US 5 432 053

D2 - Journal of Heart and Lung Transplantation, vol 11, no. 4, part 1, July/August 1992, pages 607-18

D3 - US 5 370 989

D4 - US 5 145 771

D5 - US 4 789 824

D6 - Clinical and Experimental Pharmacology and Physiology, vol. 26, no. 1, 1999, pages 20-25

The claims of the instant application relate to a pharmaceutical or veterinary composition comprising: (a) a potassium channel opener or agonist and/or an adenosine receptor agonist and (b) a local anaesthetic. They also encompass uses of these compositions to arrest, protect and/or preserve an organ.

NOVELTY (N) Claims 1-5, 28-29

D1 discloses a solution for conservation of living organs, such as a heart, including local anaesthetic (such as lidocaine) and a purine derivative (such as inosine) which falls within the meaning of "adenosine receptor agonist". Thus claims 1-5 and 28-29 are considered to lack novelty in the light of this document.

INVENTIVE STEP (IS) Claims 1-7, 9-13, 25-29

D2 teaches the use of lidocaine (lignocaine) in the preservation of organs, eg. hearts. D3 teaches the use of adenosine 3',5'-cyclic monophosphate analogues or guanosine 3',5'-cyclic monophosphate analogues (which fall within the scope of adenosine receptor agonist) in solutions for organ preservation and maintenance. D4 and D5 teach a solution for the preservation and storage of organs and tissue comprising adenosine. D6 teaches the use of pinacidil in ischaemic preconditioning of rats hearts prior to hypothermic storage.

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

**Continuation of**

The problem solved by your invention is to provide an efficacious cardioplegic that reduces the damage caused by ischaemia and places the heart into a hypometabolic state.

The skilled addressee would have combined the teachings of D1 and D2 (which teach the use of lidocaine in heart preservation) and with the common general knowledge (to wit, the use of adenosine receptor agonists in heart preservation as demonstrated by D3-D5) to arrive at a solution the same as the invention claimed in claims 1-7, 9-13 and 25-29. Consequently, claims 1-7, 9-13 and 25-29 are not considered to involve an inventive step when compared with the prior art.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU00/00226

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>												
Int. Cl. <sup>7</sup> : A01N 1/02												
According to International Patent Classification (IPC) or to both national classification and IPC												
<b>B. FIELDS SEARCHED</b>												
Minimum documentation searched (classification system followed by classification symbols)												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CA: (potassium channel openers or ion channel openers or potassium channel agonist or purinoceptor agonist) and (anesthetics); MEDLINE: (organ preservation solutions and anesthetics) or (lincaine and adenosine)												
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
X	US 5 432 053 (BERDYAEV ET AL.) 11 July 1995 whole document	1-5, 25-28										
Y	SULTAN, I., et al., "Heart Preservation: Analysis of Cardioprotective Infusate Characteristics, Membrane Stabilization, Calcium Antagonism, and Protease Inhibition on Myocardial Viability: A Biochemical, Ultrastructural, Functional Study", Journal of Heart and Lung Transplantation, Vol. 11, No. 4, Part 1, July/August 1992, pages 607-18 whole document	1-7, 9-13, 25-29										
Y	US 5 370 989 (STERN et al.) 6 December 1994 whole document	1-7, 9-13, 25-29										
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input type="checkbox"/> See patent family annex												
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td>"&amp;" document member of the same patent family</td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention											
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone											
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art											
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family											
"P" document published prior to the international filing date but later than the priority date claimed												
Date of the actual completion of the international search 23 May 2000		Date of mailing of the international search report 09 JUN 2000										
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustrialia.gov.au Facsimile No. (02) 6283 3929		Authorized officer  JAMIE TURNER Telephone No.: (02) 6283 2071										

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
PCT/AU00/00226

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	5 432 053	RU	2025973	WO	93/15604	AU	14580/92
US	5 370 989	US	5552267				
US	5 145 771						
US	4 798 824	AU	608744	CA	1282342	EP	237567
		WO	87/01940	US	4879283	US	4873230
		AU	609236	BE	1003362	CH	678912
		DE	3843958	FR	2625073	GB	2213362
		HU	49782	IT	1227916	JP	1246201
		NL	8803186	NZ	227516	PH	27182
		SE	8804661	ZA	8809683		

END OF ANNEX

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU00/00226

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, identification, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 145 771 (LEMASTERS et al.) 8 September 1992 whole document	1-7, 9-13, 25-29
Y	US 4 798 824 (BELZER et al.) 17 January 1989 whole document	1-7, 9-13, 25-29
Y	HICKS, M., et al., "ATP-Sensitive Potassium Channel Activation Mimics the Protective Effect of Ischaemic Preconditioning in the Rat Isolated Working Heart After Prolonged Hypothermic Storage", Clinical and Experimental Pharmacology and Physiology, Vol. 26, No. 1, 1999, pages 20-25 whole document	1-7, 9-13, 25-29



(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
27 September 2001 (27.09.2001)

PCT

(10) International Publication Number  
**WO 01/70382 A1**

(51) International Patent Classification<sup>7</sup>: **B01F 3/12,**  
B04C 5/04

(21) International Application Number: PCT/AU00/00225

(22) International Filing Date: 22 March 2000 (22.03.2000)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant and

(72) Inventor: **AGGARWAL, Rakesh, Kumar** [AU/AU]; 144  
Beach Street, Port Melbourne, VIC 3207 (AU).

ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS,  
LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ,  
PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT,  
TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM,  
KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent  
(AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent  
(AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU,  
MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM,  
GA, GN, GW, ML, MR, NE, SN, TD, TG).

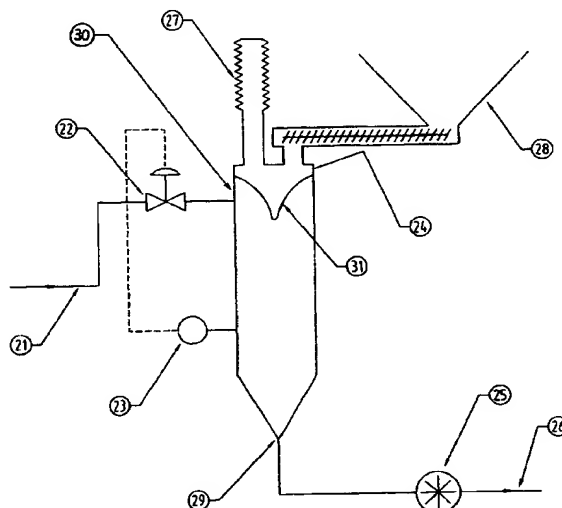
Published:

— with international search report

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE,  
DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU,

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: **APPARATUS FOR MIXING A SOLID AND A LIQUID**



(57) Abstract: Apparatus for in-line and continuously mixing a particulate solid and a liquid, while removing air at the same time, includes a mixing vessel (24), into which a liquid is introduced tangentially through a tangential entry (30). The rotation of the liquid induces a vortex (31) whose depth is limited so that it does not reach the outlet (29) of the mixing vessel (24). The particulate solid is deposited by an auger feeder (28) onto the vortex (31), and spins outwards due to centrifugal force, while interstitial air moves towards the centre and discharges into the vortex (31). The mixed liquid is withdrawn from the outlet (29) of the mixing vessel (24) by means of a pump (25). The pump (25) provides further mixing, and pressure for transporting the liquid. The level in the mixing vessel (24) is controlled by a level sensor (23), and a control valve (22) in the incoming line (21) of the apparatus.

WO 01/70382 A1

## APPARATUS FOR MIXING A SOLID AND A LIQUID

The present invention relates to apparatus and a method for mixing a solid and a liquid, and more particularly relates to a solids/liquid mixing device which removes air from the product at the same time as mixing takes place. The  
5 apparatus may also be used for mixing a plurality of liquids.

Many processes in the food, pharmaceuticals and chemical industry call for the mixing of solids into liquids, to prepare a solution or suspension of a precise composition.

Quite often this is done discontinuously, in many steps. Firstly, a tank is filled  
10 with a known quantity of liquid. Next, the required amount of solid material is dumped into the tank. Thirdly, the contents of the tank are vigorously mixed to achieve a uniform distribution and an homogeneous solution. Sometimes, a pump is used to circulate the product and achieve mixing. The product is then ready for use.

15 The above process has many disadvantages, some of which are listed below:-

(a) It is a batch process which normally has to integrate with a continuous, process thus necessitating two independent mixing units.

(b) Vigorous mixing can lead to aeration of the product, which may not be desirable.

20 (c) Sometimes an additional solvent may be required to prepare a solution, for example the addition of lactose in milk is traditionally achieved by making a lactose solution in water, which water ultimately needs to be evaporated, costing energy.

There is some proprietary equipment available on the market for industrial  
25 application, which relies upon closing the solids in the eye of a vertically mounted

impeller, and accurately controlling the feed in and feed out of liquid. Such equipment is fairly complex and relies upon extensive instrumentation and controls. This leads to aeration of the product.

Other available equipment relies upon vigorous agitation to achieve mixing. This  
5 introduces air into the product and results in a very high energy consumption. This may damage the shear sensitive products.

The mixer in AU-B-30882/95 uses the same principle, but does not provide for air removal and in-line use. It relates to batch process equipment.

It is an object of the present invention to provide a means of mixing solids into  
10 liquids as a continuous process, with a low energy cost and while removing air at the same time.

The invention provides apparatus for mixing a solid and a liquid, including a mixing vessel having an inlet for said liquid, means to introduce said solid into said vessel, and an outlet from said vessel for a mixture of said solid and said  
15 liquid, characterised in that said liquid is introduced into said vessel through a tangential entry, to rotate the liquid in said vessel, the rotation of said liquid causing the formation of vortex in said vessel, and in that said solid is deposited into said vortex.

The invention also provides a method of mixing a solid and a liquid, including the  
20 steps of:-

introducing said liquid tangentially into a mixing vessel, such that rotation of the liquid in said vessel takes place, such that a vortex is created in said liquid in said vessel; and

introducing said solid into said vortex.

25 The invention further provides an apparatus for mixing liquids and particulate

solids comprising a vessel with inlet and outlet for said liquid,  
said liquid said inlet for introducing said liquid into the said vessel,  
a means to create a rotating said liquid in a manner that the air core in the  
middle of the said rotating said liquid does not reach the said outlet of the  
5 said vessel,  
said particulate solids inlet means for introducing a stream of said  
particulate solids into the said rotating liquid,  
and  
removing the mixed said liquid and said particulate solids from the said  
10 outlet of the vessel.

Additional objects and advantages of the invention will be set forth in the  
description which follows, and in part will be obvious from the description, or may  
be learned by practice of the invention. The objects and the advantages of the  
invention may be realised and obtained by means of the instrumentation and  
15 combinations particularly pointed out in the description and their equivalents.

To achieve the foregoing objects, and in accordance with the purposes of the  
invention as embodied and broadly described herein, there is provided an  
apparatus and process to achieve an in-line mixing of solids and liquids. The  
apparatus consists of a solids (or liquid) dosing equipment and an appropriate  
20 method of generating a centrifugal force in liquid. The centrifugal force thus  
generated is limited in magnitude so as to avoid the air core in the eye or vortex  
from reaching the liquid outlet port. The solids (or liquids) are dropped on the  
surface of the liquid. The solids that have a density higher than the liquid are  
subjected to a centrifugal force according to Stokes' law, and move towards the  
25 wall of the vessel. The gases or air which are generally lighter than the liquid  
tend to move towards the centre again due to the centrifugal forces and the  
Stokes' law or principle. The rotating liquid creates an interface with the solids  
surface and that facilitates suspension or solution of the solid. This mixer has  
the following advantages:-

30 (a) It is an in-line continuous process thus does not need holding tanks and

vessels;

(b) The mixing action is very gentle and the centrifugal force used for mixing also removes the air, it does not vigorously mix, and does not aerate the product; and

(c) It does not need an additional solvent like batch processes do.

5 Other objects and advantages are:-

(a) The energy consumption is extremely low in this process;

(b) The equipment is washed in-line and does not need separate washing;

(c) The equipment has a small footprint and needs very little space compared to batch mixing which needs tanks and pumps; and

10 (d) The control system to integrate this concept in an automatic plant are very simple.

The invention may be seen to be apparatus and a method for in-line and continuously mixing a particulate solid and a liquid, while removing air at the same time. It may include a mixing vessel, into which a liquid is introduced  
15 tangentially through a tangential entry. The rotation of the liquid induces a vortex whose depth is limited so that it does not reach the outlet of the mixing vessel. The particulate solid is deposited by an auger feeder onto the vortex, and spins outwards due to centrifugal force, while interstitial air moves towards the centre and discharges into the vortex. The mixed liquid is withdrawn from the outlet of  
20 the mixing vessel by means of a pump. The pump provides further mixing, and pressure for transporting the liquid. The level in the mixing vessel is controlled by a level sensor, and a control valve in the incoming line of the apparatus.

An embodiment of the invention, which may be preferred, will be described in detail hereinafter, with reference to the accompanying drawing, in which:-

Fig.1. is a schematic diagram of an embodiment of a solids and liquids mixing apparatus according to the present invention.

Fig. 1, which is incorporated in and constitutes a part of the specification, illustrates a preferred embodiment of the invention and together with the general description given above and the detailed description of the preferred embodiment and the description of an actual trial unit given below, serve to explain the principles of the invention.

According to the embodiment of Fig. 1, the components of the apparatus of the preferred embodiment, and the reference numerals denoting them, are:

10	28	Auger feeder
	27	Bag filter
	24	Mixing vessel
	22	Control valve (for the liquid line to maintain level in the mixing vessel 24)
15	23	Level transmitter or sensor
	25	Mixing pump
	26	Product outlet line
	21	Liquid incoming line
	30	Tangential entry to mixing vessel 24
20	29	Outlet port of mixing vessel 24
	31	A typical shape of the vortex formed due to liquid entering the mixing vessel 24 through tangential entry 30

The apparatus of Fig. 1 includes a liquid incoming line 21 in which is located a control valve 22. Line 21 has a tangential entry 30 to mixing vessel 24. Reference numeral 31 denotes the typical shape of the vortex formed in mixing vessel 24 as a result of the liquid entering the vessel through tangential entry 30. Auger feeder 28 is connected to mixing vessel 24. A bag filter 27 is connected to the top of the mixing vessel 24. A level sensor or transmitter 23 is mounted on a mixing vessel 24, and is connected to control valve 22.

Mixing vessel 24 has an outlet port 29 which is connected to mixing pump 25 which in turn is connected to a product outlet line 26. The auger feeder 28 is typically a commercially available unit. The mixing pump 25 is a commercially available pump of required flow rate and head. The mixing vessel 24 is typically  
5 a cylindrical vessel with a conical base, having, preferably, a diameter of 150mm diameter and a length of 1000mm.

From the description above, a number of advantages of the apparatus become evident:

(a) It is an in-line continuous process, and thus does not need holding tanks and  
10 vessels;

(b) The mixing action is very gentle and the centrifugal force used for mixing also removes the air, and thus it does not vigorously mix, and does not aerate the product which may not be desirable;

(c) It does not need an additional solvent like batch processes do.

15 (d) The energy consumption is extremely low for this process.

(e) The equipment can be washed in-line and does not need separate washing.

(f) The control system to integrate this concept in the automatic plant are very simple.

The operation of the apparatus of this embodiment of the present invention as  
20 in-line equipment is identical to any in-line equipment for liquid processing. It continuously receives a stream of liquid, processes the incoming liquid in real time and discharges the liquid continuously after processing.

There is a liquid incoming line 21 which supplies liquid through the control valve 22. Control valve 22 controls the level in mixing vessel 24. Liquid enters mixing

vessel 24 via a tangential entry 30. The tangential entry velocity thus developed is used to create a rotating motion and create a centrifugal force. The centrifugal force is controlled such that a vortex 31 is formed. Reference numeral 31 shows a typical shape of the vortex. The vortex 31 is limited in depth such that it does not reach outlet port 29 of mixing vessel. The control valve 22 maintains the level in mixing vessel 24 by using the signal from the level transmitter or sensor 23.

The solids are dosed at a controlled rate by auger feeder 28. The dust thus generated is trapped by the bag filter 27, while the excess air is allowed to escape. Solids make contact with the rotating liquid in mixing vessel 24. The centrifugal force spins the particulate solids towards the inner wall of mixing vessel 24. All particulate solids have interstitial air. This air, which is lighter, moves towards the middle of mixing vessel 24 and discharges in the vortex cone 31 as shown in Fig.1.

The solids mixed with the liquid move to an outlet port 29 of mixing vessel 24 and are drawn to the pump 25. The pump 25 has a mixer, size reduction equipment and a pressure generator. The mix coming out at product outlet line 26 is an homogenous mix of the solids in the liquid.

The size of the mixing vessel 24 and the flow rate of liquid through the apparatus is determined by the characteristic of the liquid and solid(s).

While it is believed that the physics involved in the operation of the apparatus of this invention may be explained by:-

- (a) Stoke's law of centrifugal forces;
- (b) The principle of vortex formation in rotating liquids;
- (c) The principle of cyclone operation;



this description is not bound by such an explanation.

The configuration of the apparatus according to the present invention is not limited to the preferred embodiments disclosed.

A trial unit of apparatus for mixing a solid and a liquid was built in accordance  
5 with the schematic diagram of Fig. 1.

The trial unit was used to add lactose powder to milk for protein standardisation. The milk flow rate was 6,000 litres per hour and the lactose powder to be added was 300kg per hour.

Pump 30 was rated at 6,000 litres per hour, feeding to the evaporator. Line 21  
10 (size 40 mm) fed to the mixing vessel 24. Accordingly, 300kg of lactose was added to 6,000 litres of milk per hour. Pump 24 is a centrifugal pump with a 1.0 kW motor running at 1350 rpm.

The alternate technology required two 30,000 litre tanks with necessary mixing, pasteurising equipment and with provision for cleaning using hot detergents. The  
15 product was still prone to bacterial contamination. Since the solution was made using water, the water had to be evaporated which increased energy usage as well.

In another experiment, the trial unit was used for mixing starch into water. This was equally successful.

20 In another trial it was used for mixing skim milk powder into the water. This is a very difficult application and always tends to generate foam. In the trial unit, no foam was formed at all.

In another experiment, the trial unit was used for mixing lactose into skim milk concentrate (viscosity equal to 50cps), and the unit performed in accordance with  
25 expectation.

Thus, the addressee will see that the apparatus and method of this invention provides:-

- (a) An in-line continuous process thus does not need holding tanks and vessels;
- (b) A gentle mixing action and removal of air, without aeration of the product,  
5 which would have played havoc with the vacuum control of a multi effect evaporator;
- (c) No requirement for an additional solvent like batch processes require;
- (d) The equipment may be washed in-line and does not need separate washing;
- (e) The equipment has a small footprint and needs very little space compared to  
10 batch mixing which needs tanks and pumps;
- (f) The control systems to integrate this concept into an automatic plant are very simple; and
- (g) It may be used with a large variety of products.

While the above description contains many specificities, these should not be  
15 construed as limitations on the scope of the invention, but rather as an exemplification of one preferred embodiment thereof. Many other variations are possible. For example, if the flow rate required is lower than what is required to form a proper vortex, a part of the mixed liquid can be recirculated through the liquid inlet line.

20 In another example if the flow rate in the line is too large, only a part of the liquid stream can be passed through the apparatus.

Alternative means of level control can be used too. As an example, if it is connected to an existing balance tank, the height of the apparatus may be such

designed that the level control is not required at all.

Alternative means to tangential entry can be used for generating a rotating liquid. This could be a mechanical means like a rotating mechanical device which induces a rotation in the liquid.

- 5 The apparatus may be used for mixing liquids as well. In place of the deposition of solids particulate matter, a different liquid may be deposited into mixing vessel 24.

Additional advantages and modifications will readily occur to those skilled in the art. The invention in its broader aspects is, therefore, not limited to the specific  
10 details, representative apparatus and illustrative examples shown and described. Accordingly, departures from the spirit or scope of the invention can be made.

## CLAIMS

1. Apparatus for mixing a solid and a liquid, including a mixing vessel having an inlet for said liquid, means to introduce said solid into said vessel, and an outlet from said vessel for a mixture of said solid and said liquid,  
5 characterised in that said liquid is introduced into said vessel through a tangential entry, to rotate the liquid in said vessel, the rotation of said liquid causing the formation of vortex in said vessel, and in that said solid is deposited into said vortex.
2. Apparatus according to claim 1, characterised in that vortex is controlled  
10 such that the air core at the centre of said vortex does not reach said outlet.
3. Apparatus according to claim 1 or claim 2, characterised in that said solid is a particulate solid.
4. Apparatus according to claim 3, characterised in that said particulate solid  
15 is deposited into said vessel in a stream.
5. Apparatus according to claim 3 or claim 4, characterised in that said particulate solid is deposited into said vessel through an auger feeder.
6. Apparatus according to any preceding claim, characterised that sensing  
20 means is provided to sense the level of liquid or mixture in said vessel, and in that a control valve is located in an incoming line communicating with said inlet, said control valve acting to control the flow of said liquid in accordance with the information from said sensing means and in relation to a predetermined level in said vessel.
7. Apparatus according to any preceding claim, characterised that a pump is  
25 provided to pump mixture from said outlet.

8. A method of mixing a solid and a liquid, including the steps of:-  
  
introducing said liquid tangentially into a mixing vessel, such that rotation of the liquid in said vessel takes place, such that a vortex is created in said liquid in said vessel; and
- 5 introducing said solid into said vortex.
9. A method according to claim 8, characterised in that said solid is a particulate solid.
10. A method according to claim 9, characterised in that said particulate solid is deposited into said vortex by an auger feeder.
- 10 11. A method according to any preceding claim, further including the step of removing the mixture of said solid and said liquid from said vessel.
12. A method according to any preceding claim, characterised in that said vortex is controlled such that the air core therein does not reach the outlet of said vessel, through which a mixture of said solid and said liquid is  
15 removed from said vessel.
13. A method according to any preceding claim, further including the step of controlling the level of said liquid and/or said mixture of said liquid and said solid in said vessel.
14. An apparatus for mixing liquids and particulate solids comprising a vessel  
20 with inlet and outlet for said liquid,  
said liquid said inlet for introducing said liquid into the said vessel,  
a means to create a rotating said liquid in a manner that the air core in the middle of the said rotating said liquid does not reach the said outlet of the said vessel,  
25 said particulate solids inlet means for introducing a stream of said

particulate solids into the said rotating liquid,  
and  
removing the mixed said liquid and said particulate solids from the said  
outlet of the vessel.

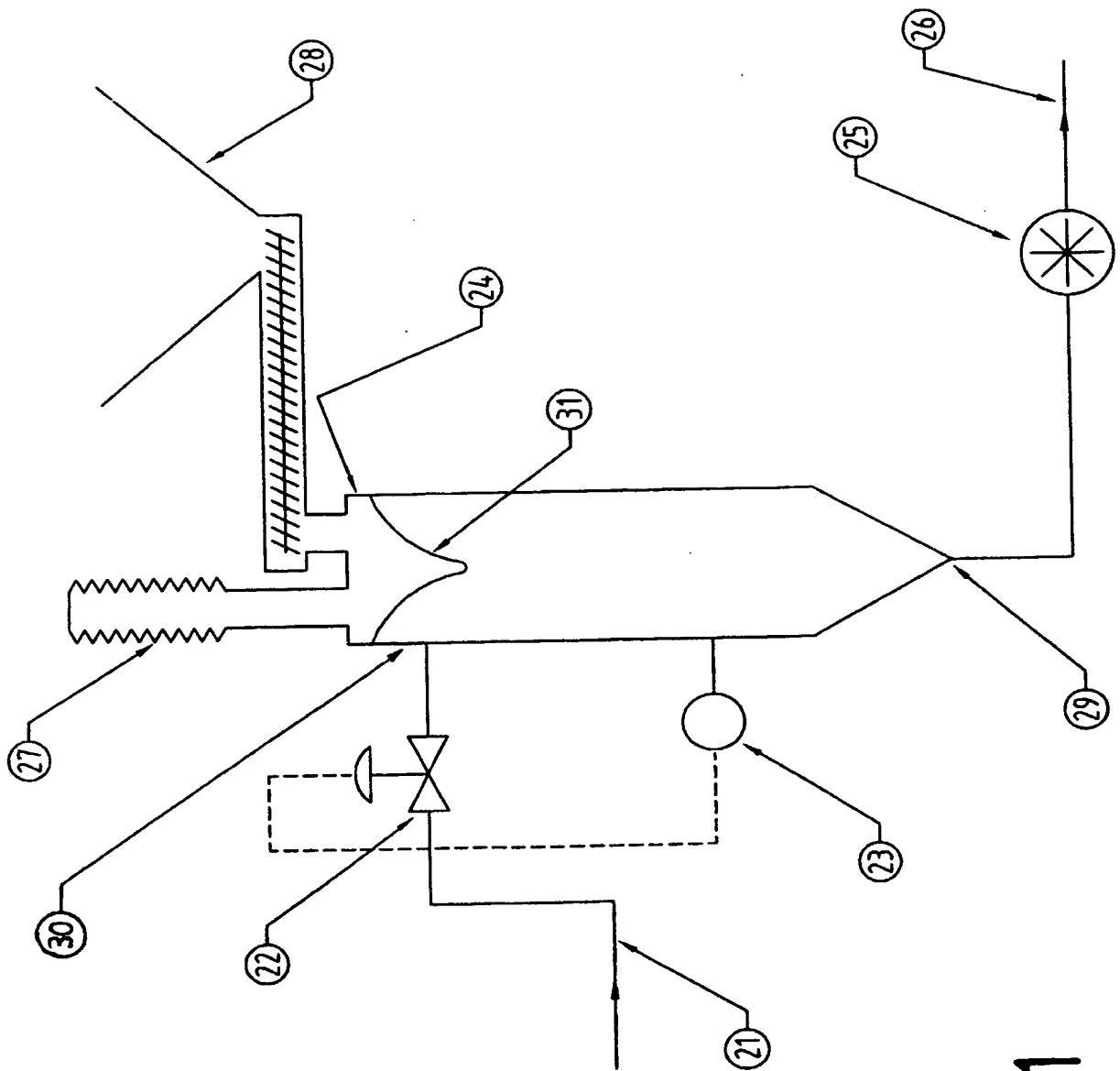


Fig 1

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 00/00225

**A. CLASSIFICATION OF SUBJECT MATTER**Int Cl<sup>7</sup>: B01F 3/12, B04C 5/04

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

B01F 3/12, B04C 5/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPAT: vortex

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4184771 A (DAY) 22 January 1980 whole document	1-14
X	GB 2031748 A (HEPHERD et al) 30 April 1980 whole document	1-14
X	US 5039227 A (LEUNG et al) 13 August 1991 whole document	1-14

☒ Further documents are listed in the continuation of Box C☒ See patent family annex

* Special categories of cited documents:	
"A" Document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

17 April 2000

Date of mailing of the international search report

- 5 MAY 2000

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE  
PO BOX 200  
WODEN ACT 2606 AUSTRALIA  
E-mail address: pct@ipaustalia.gov.au  
Facsimile No.: (02) 6285 3929

Authorized officer

*R. D. L. D. J. J.*  
**ASOKA DIAS-ABEYGUNAWARDENA**  
Telephone No.: (02) 6283 2141



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 00/00225

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	W0 99/31552 A (JENSON et al) 24 June 1999 entire document	1-14
X	US 5122348 A (SPENCE et al) entire document	1-14

### Information on patent family members

International application No.

PCT/AU 00/00225

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member				
US	4184771	AU 42493/78	BE 873165	CA 1100480	DE 2900931	ES 476717
		FR 2433969	GB 2028673	JP 55032893	LU 80753	NL 7812501
		PT 69001	BE 885588	AU 62454/80	CA 1146163	DE 3039342
		ES 495657	ES 8301424	GB 2078124	IT 1128581	JP 57012822
GB	2031748	DK 4190/79	FR 2438497			
US	5039227	NONE				
WO	99/31552	AU 16636/99				
US	5122348	AU 10029/92	BR 9200045			